AN INVESTIGATION OF THE SEED OF THE CASSIA OCCIDENTALES

A THESIS

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by

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INTRODUCTION

Various species of the Cassia family are distributed over the tropical and temperate regions of the earth. They are closely related to the Senna group of plants and are very hardy and prolific. The plant is an annual growing from one to five feet in height and bearing small yellow blossoms and thin pods containing the seed. (9)

Several species are known collectively as coffee-weed, stink-weed, wild-coffee, or wild-senna. In the United States there are three species that are rather widely distributed over the Southern states. These are the Cassia tora, the Cassia occidentales, and the Cassia medsgeri. All of these occur in the state of Georgia.

In a search of the literature for records of investigations on these plants it was found that very little had been reported. In India the leaves, seed, and roots have an important place in native medicine. (3) They are used as a gentle laxative, as a relief for asthma, as a poultice to hasten suppuration, as a remedy against itch, ring-worm, and other skin diseases, and by the native Indian dyers as a means of obtaining certain color effect with indigo. (11)

In many parts of the world the roasted seed have been used as a coffee substitute and adulterant, (10,11,12) although there is no caffein present. From the Poona Agricultural College in India (12) comes a report of an investigation of the seed of the Cassia tora as to its fitness as a coffee

substitute. The most important contribution of this report was the conclusion that no harmful effects were produced in the use of the roasted seed. From the Journal of the Indian Chemical Society comes a report of a more thorough investigation of the seed and oil of the Cassia tora. The physical and chemical constants of the oil were determined; oleic, linolic, palmitic, and lignoceric acids were reported to be present in the oil; and sitosterol and a glucoside were reported in the unsaponifiable matter.(11)

The only report found on the Cassia occidentales was in the Recueil des Travaux Chimiques des Pays-Bas.(10) Some of the physical and chemical constants of the oil were given, and 9-oleic, linolenic, and linoleic acids were reported to be present. No investigation of the unsaponifiable matter, the physiological action of the oil or seed, the mineral content of the seed, or the presence of glucosides and alkaloids was undertaken. Since this species occurs quite extensively in the southern states, it was decided to investigate the seed and oil of the Georgia-grown Cassia occidentales.

The aims of this investigation are to check or determine for the first time the most important physical and chemical constants of the oil, to make a mineral analysis of the meal, to investigate the unsaponifiable matter of the oil, and to check any other property or properties of interest. It was desired to work out an efficient method by which to extract the oil from the seed and to obtain enough of the oil to make the above investigations. Since the meal left

after extraction would contain practically all the mineral matter from the original seed, the mineral analysis was to be made on this meal rather than on the original seed.

In the investigation of the unsaponifiable matter it was desired to find some constituent of medicinal value, since various claims have been made for the oil.

EXPERIMENTAL PROCEDURES

GRINDING AND EXTRACTION

The ripened seed pods were gathered from October to January. These seed pods were threshed, and the seed separated from the hulls and other material. The seed as received at the laboratory were free from any visible extraneous material and were used in all the following work without further cleaning.

Crushing or grinding with the ordinary laboratory type mill failed to give a fine meal, or failed to give any results at all. An old-style coffee mill was tried, which gave somewhat better results, but the meal was not sufficiently fine for efficient extraction and the method was laboriously slow. The only mill that would give satisfactory results was a small hand-powered flour mill. The grinding mechanism of this mill consists of two burrs, one fixed and the other movable. The degree of fineness of the meal is controlled by a screw which varies the distance between the two burrs. This mill gave a product in which the yellow kernel of the seed was very finely divided, while the shell of the seed came through the mill in larger flatter particles.

The seed were ground as the meal was needed for a given extraction. The shells were not separated from the yellow kernel, but the whole meal was extracted. This procedure gave a more porous mass and afforded smoother extraction.

A large Soxhlet-type extractor was designed for the extraction of the oil from the seed. A glass delivery tube

was inserted into the bottom of a three-liter boiling flask. This tube was, by proper bending, made to give a siphoning effect into a five-liter boiling flask containing the extracting solvent. This siphon tube was not continuous but had a ground-glass joint in the vertical section to make for easier assembly of the apparatus. From the solvent flask an asbestos-wrapped glass tube delivered solvent vapors to the top of the extraction flask, which was also fitted with a water cooled Hopkins condenser. The vapors came through the tube to the condenser, where they were condensed and returned to the meal contained in the extraction flask. This meal was supported on the bottom of the flask by a weighted filter paper over which was spread glass wool to aid in the filtering. The solvent was heated by means of an electric hot-plate with a temperature control. Thus, a continuous extraction process requiring but very little attention was realized.

The procedure for a given extraction was to place the weighed freshly-ground meal into the extraction flask, fill the solvent flask about two-thirds full of solvent, assemble the apparatus, regulate the heat until the ratio of solvent from the condenser to that returning to the solvent flask was such that no flooding of the system would take place, leave the extraction running for such a length of time for complete extraction, and then recover the oil extracted. The length of time was determined by observing the color of the returning solvent. Since the oil is colored, the absence of any appreciable amount of oil could be determined by observing the lack

of such color in the returning solvent. The extraction was continued for one hour after the disappearance of the color to insure complete extraction. Carbon tetrachloride was the extracting solvent in all of the extractions.

When the extraction was judged to be complete, the heat was turned off, the solution allowed to cool, and any suspended matter that might have siphoned over was then removed by filtering through a Buchner funnel. The solvent was then removed by distillation over a steam bath. The meal left in the extraction flask was then set aside for later study.

When most of the solvent had distilled over, the oil containing the residual solvent was transferred to a weighed Erlenmeyer flask, this placed on a steam bath, and suction applied by means of an efficient aspirator. It was found that several hours were required for the removal of the last traces of solvent. This was determined by weighing the flask at intervals until constant weight was obtained. It was then judged that all solvent had been driven off. The flask was tightly stoppered and placed in a dark place until the oil was needed. This was done for fear that components sensitive to air and light may be present.

The yield of oil on the different batches was very consistent, being about 3.0% based on the weight of the meal extracted. This, it is to be kept in mind, is the yield using carbon tetrachloride as a solvent. Other solvents would most probably give different yields, and successive extractions with different solvents would no doubt give a higher total yield.

EXAMINATION OF THE SEED AND MEAL

DESCRIPTION OF THE SEED

During the time that the extraction process was being worked out and a supply of oil was being obtained, a study was made of the physical and chemical properties of the seed and extracted meal.

The seed are slightly longer than wide, being about four to five millimeters in length. They have a very hard, elastic, dark-brown shell. The kernel is yellow to orange in color and comprises approximately twenty-five percent of the total weight of the seed. The average weight of the seed, found by weighing fifty representative seed, was 16.3 mg. as compared to the value in the literature of "about 20 mg."(10) However, the difference in the locality from whence the seed came would probably explain this difference.

The percent ash in the seed was obtained by weighing accurately three samples of the seed and igniting to constant weight over a Mekker burner. The average value, based on the weight of the seed taken, was found to be 3.28%.

In an attempt to obtain the percent moisture and volatile matter in the seed by heating a weighed quantity of the ground meal in an electric oven at 102°-103° C., it was found that a constant weight could not be obtained and that the meal changed color. It was concluded that chemical changes were taking place on heating and that any results would probably be ambiguous.

DETERMINATION OF PHOSPHORUS

The ash from the extracted meal was analysed for phosphorus among other components. The ash was obtained by ashing a quantity of the meal from which the oil had been extracted. A stock supply of this ash was stored in a desiccator to be used as needed. The method used for the phosphorus determination was the volumetric molybdate method. (7) As some difficulty was had in obtaining results which would check, an outline of the method will be given.

A .3000 gram sample of the ash was taken into solution with 10-12 ml. of dilute nitric acid, the resulting solution was barely neutralized with ammonia using methyl red as an indicator, and then made slightly acidic by adding dilute nitric acid dropwise. This solution was diluted to 100 ml. and adjusted to 25°-30° C. About 40 ml. of the molybdate solution was now added, the solution tested for complete precipitation, and allowed to stand at room temperature for 30 minutes. The supernatant liquid was decanted through a filter and the precipitate washed two or three times by decantation with 30-ml. portions of cold water. The precipitate was then transferred to the filter paper and washed seven times with a 2% solution of ammonium nitrate. The paper containing the precipitate was then transferred to the flask from which it came, an excess of standard NaOH solution added, and the excess alkali then titrated with standard HCl solution using phenolphthalein as an indicator. The ammonium phosphomolybdate precipitate dissolved according to the following reaction:

$$(NH_4)_3PO_4.12MoO_3 + 23NaOH = Na(NH_4)HPO_4 + (NH_4)_2MoO_4 + 11Na_2MoO_4 + 11H_2O$$

The normality of the NaOH solution was .4634. The calculations were based on the above equation. The results are summarized in the following table:

Det.	Wt. Sample	Ml. NaOH used	$\%P_2O_5$ in ash	%P	%P in Seed
1	.3000 g.	65.4	31.18	13.62	.447
2	.3000 g.	65.5	31.22	13.63	.447
Av.	-	-	31.20	13.63	.447

DETERMINATION OF CALCIUM

Two methods were used in this determination. Since phosphates interfere with the precipitation of calcium as the oxalate, the phosphorus was removed by precipitating the phosphates as the ammonium phosphomolybdate and filtering it from the solution. The calcium was then precipitated from this solution as the oxalate by the usual procedure. This was then ignited to the oxide and weighed as such. No concordant results were obtained by this method.

A second method, as suggested by Hillebrand and Lundell, (5) in which the calcium was precipitated as the oxalate in an oxalic acid solution was used for this analysis. Phosphates do not interfere in acid solution, but the solution can not be too acidic, for then the calcium oxalate would dissolve. By experiment it has been determined that calcium oxalate is not appreciably soluble in an oxalic acid solution. The method was followed in its entirety as outlined on page 500 of the above reference and will not be given in detail here. Two determinations were run. The results are summarized below:

Det.	Wt. Sample	Wt. CaO	%CaO	% Ca	% Ca in seed
1	.5000	.0412	8.24	5.89	.193
2	.5000	.0409	8.18	5.85	.193
Av.	.5000	.04105	8.21	5.87	.193

DETERMINATION OF MAGNESIUM

The oxalate method as employed by Hillebrand and Lundell (5) was used in this determination. The magnesium in the oxalic acid filtrate from the calcium determination was precipitated as magnesium ammonium phosphate, ignited to magnesium pyrophosphate, and weighed. To insure uniform results double precipitations were made in all cases.

Det.	Wt. Sample	Wt. $Mg_2P_2O_7$	%Mg	%Mg in Seed
1	.5000	.1987	8.68	.285
2	.5000	.2025	8.85	.289
Av.	.5000	.2006	8.76	.287

DETERMINATION OF IRON

This determination was done colorimetrically using a standard colorimeter. A 0.5000 gram sample of the ash was dissolved in 50 ml. of concentrated nitric acid, boiled to oxidize any ferrous iron, 2 ml. of concentrated sulfuric acid added, and the solution diluted to 250 ml. in a volumetric flask. Samples of the solution were placed in the colorimeter tubes and a few drops of very dilute potassium permanganate solution added. A standard iron solution containing 0.007115 grams of iron per liter was prepared and samples of this were treated similarly to the others. To both known and unknown were now added the same number of drops of an ammonium thiocyanate solution. The results are summarized in the following table:

Det.	Reading Known	Reading unknown	%Fe	%Fe in seed
1	20	8	.890	.0304
2	30	12	.890	.0304
3 (?)	40	15.8	?	?
Av.	2.5	1	.890	.0304

On comparing these values with values for ash of similar type, it was found that the above value for iron was somewhat high . This is most probably due to the iron introduced into the meal by grinding between the steel burrs of the mill.

DETERMINATION OF NITROGEN

A standard Kjeldahl method was used on the whole seed. Three 3.000-gram samples of the seed were digested with concentrated sulfuric acid. A small amount of salicylic acid was added at the beginning to fix any nitrates that might have been present. The procedure is that outlined in Mahin's text, pages 528-539. (7) The evolved ammonia was collected in an excess of standard acid of 0.5353 normality and the excess acid then titrated with standard sodium hydroxide solution. One determination was discarded to eliminate an error occurring in the experimental procedure. The results are summarized below:

Det.	Wt. sample	Ml.HCl used	% NH_3	% Nitrogen
1	3.000	12.78	3.88	3.19
2	3.000	12.78	3.88	3.19
Av.	-	-	3.88	3.19

NATURE OF THE IGNITED ASH OF THE MEAL

A 0.5000 gram sample of the ash was boiled with 25 ml. of water, filtered on an ashless paper, washed several times with hot water, and the filtrate then titrated with standard

hydrochloric acid solution, using methyl red as an indicator. This was done in order to determine the relative alkalinity of the water-soluble and the water-insoluble ash. (4) The results, calculated to 100 grams of ash, showed that 256 ml. of 1N HCl would be required to neutralize the 100 grams of ash.

The water-insoluble ash was ignited in a weighed crucible and the weight of the ash was found to be 0.2780 grams. This ignited ash was then dissolved in an excess of standard HCl and back-titrated with a standard sodium hydroxide solution. On the same basis as above the water-insoluble ash would require 878 ml. of 1N HCl for the neutralization of 100 grams. While these results are not highly accurate, they give an idea of the relative alkalinity of the two portions of the ash.

By calculating the percent water-insoluble ash from the weight found and by difference obtaining the percent water-soluble ash, it was found that the ash is 55.6% water-insoluble and 44.4% water-soluble.

ENZYMATIC ACTION OF THE SEED

To determine the presence or absence of enzymes in the seed, a portion of the ground meal was placed in a sterile bottle, boiled distilled water was added, and the bottle stoppered with a rubber stopper containing a sterile delivery tube with a clamp. After forty-eight hours at room temperature much carbon dioxide was being evolved, as shown by leading the evolved gases into a solution of $Ba(OH)_2$. The ferment-

ing solution was strongly acidic with an organic acid. This solution also gave a heavy precipitate with Fehling's solution, showing the presence of reducing groups. These were probably reducing sugars formed by enzymatic action on carbohydrate material in the seed. No such tests were shown by fresh aqueous extracts of the meal. No starch was detected with iodine solution either before or after fermentation.

PHYSICAL AND CHEMICAL CONSTANTS OF THE OIL

PHYSICAL EXAMINATION

The oil is rather viscous and has a dark brown appearance. Its refractive index at 25° C. was 1.4763 and varied but little on the various samples checked. The refractive index was determined by means of an Abbé refractometer. On a sample of the oil which had been purified by drying the carbon tetrachloride solution with anhydrous sodium sulfate and then boiling with activated charcoal, the refractive index at 25° C. was 1.4770. Thus it would seem that the oil as obtained was sufficiently pure without further purification. The specific gravity as determined with a Pycnometer at 25° C. was .9256, which compared very well with oils of similar origin.

SAPONIFICATION NUMBER

This constant being one of the more important ones for an oil, an accurate determination is of much value in arriving at a knowledge of the properties of the oil. It is defined as "the number of milligrams of potassium hydroxide required for the saponification of one gram of the oil, fat, or wax." (6) The method used was in general that given by Griffin (4) and is practically the same as that given by Lewkowitsch. (6)

Three 5.0000 gram samples of the oil were weighed into 250 ml. Erlenmeyer flasks. Exactly 50 ml. of a .4430 N potassium hydroxide solution were added to each sample from a pipette and each resulting solution refluxed for one hour. A blank containing 50 ml. of the same potassium hydroxide sol-

ution was similarly treated. At the end of one hour the flasks were disconnected and each one titrated with .5128N hydrochloric acid solution using phenolphthalein as an indicator. The amount of KOH used in the saponification was thus found. The following table summarizes the results:

Det.	Ml. HCl used	Ml. KOH used	Sap. No.
1-	10.2	38.2	184.2
2-	10.1	38.3	184.3
3-	10.2	38.2	184.2
Av.	10.2	38.2	184.2

IODINE NUMBER

The iodine number of an oil is of special importance, since it gives a clue to the amount of unsaturation present in the oil. The iodine number is defined as the "percentage of halogen expressed as iodine, absorbed by the fat or oil."(4) (6) The method used in the following determination is the well-known Wijs modification in which the active adding halogen is iodine monochloride. This method is used by both Griffin and Lewkowitsch.

The preparation of the Wijs solution may be mentioned. The iodine monochloride was prepared as follows; Thirteen grams of resublimed iodine were dissolved in one liter of glacial acetic acid. A portion of the resulting solution was titrated against .1N sodium thiosulfate solution using starch solution as an indicator. Approximately 50 ml. of the iodine solution was set aside for later comparison. Purified and dried chlorine gas was now passed into the remainder of the iodine solution until the titration number with the thiosulfate

was just exactly doubled. A small portion of the original iodine solution was now added to remove any excess chlorine which might be present. The Wijs solution was stored in amber bottles and kept in a dark place when not in use.

For the determination of the iodine number according to Griffin (4), .4000 grams of the oil were weighed out in a glass-stoppered bottle, 25 ml. of the fresh Wijs solution were added from a pipette, the stopper of the bottle moistened with potassium iodide solution, and the bottle left to stand for one hour. This solution was then titrated with .1N sodium thiosulfate solution using starch as an indicator. Two samples were run along with two blanks. The results are summarized below:

Det.	Ml.thio.for blanks	--forsamples	ml.used	I_2-No.
1	49.25	21.9	27.4	115.9
2	49.35	21.8	27.5	116.3
Av.	49.3	-	-	116.1

ACID VALUE

The determination of the acid value gives an idea of the amount of free acids present in the oil. The constant is defined as the number of milligrams of KOH required to neutralize the free fatty acids in 1 gram of oil or fat. Briefly, the procedure is to titrate a portion of the oil with a standard base of .1N or less. (4) In this determination 5.000 grams of the oil were weighed into an Erlenmeyer flask and 25 ml. of neutral ethyl alcohol added. This mixture was heated to boiling on a steam bath and then titrated with .0500N KOH

solution. The following results were obtained:

Det.	Wt. Sample	Ml. KOH used	Acid Value
1	5.000	5.5	3.1
2	5.000	6.0	3.4
Av.	-	-	3.25

These results were rather surprising when compared to the value of 10.2 obtained by Subba Jois and Manjunath (11); however, checks made on different samples of the oil and using different strength base gave results in agreement with those above. A probable explanation of this difference is that an oil grows rancid with age and exposure to air and light. The oil used above was freshly extracted, and it would not be expected to contain much free acid.

REICHERT-MEISLL NUMBER

This constant is strictly an empirical one and any given procedure must be closely followed to obtain results which will check. The constant as defined by Lewkowitsch (6) is "the number of cubic centimeters of decinormal potash required for the neutralization of that portion of the soluble volatile acids which is obtained from 5 grams of a fat or wax by the Reichert distillation process." The method of Lewkowitsch was followed in its entirety. The value obtained was 0.44 which compares favorably to 0.5 found by Subba Jois and Manjunath. (11)

UNSAPONIFIABLE MATTER

The unsaponifiable matter was determined by saponifying

a known weight of the oil with alcoholic KOH solution and extracting the unsaponifiable matter with ether. In general Lewkowitsch's method was used. After distilling off the ether and drying the residue at 101° C. for 45 minutes, an orange-yellow solid was obtained. The weight of this solid was .7820 grams, which was 5.21% unsaponifiable matter based on the weight of the oil saponified (15 grams). This solid was set aside for later study.

SATURATED FATTY ACIDS

The soap solution from the above determination was warmed over a steam bath until most of the ether was expelled. The solution was then neutralized with dilute sulfuric acid. The dark brown free fatty acids separated as an upper layer. This layer was separated by means of a separatory funnel and washed several times with warm water. The free fatty acids became solid on cooling to room temperature. Most of the water was pressed out mechanically, and the residue dried at 105° C. for one hour. The resulting dried fatty acid mixture was used in the following separation.

In separating the fatty acids into saturated and unsaturated components, use was made of the insolubility of the lead salts of the saturated fatty acids as described by Twitchell(13) as follows:

> Weigh out in a beaker as much of the fatty acids as is estimated to contain 1 to 1.5 grams of the solid acids. In case of very liquid oils this may be 10 grams or more. Dissolve 1.5 grams of lead acetate in 95% ethyl alcohol. Dissolve the oil in 95% ethyl alcohol. Keep the total volume to 100 ml.

> Heat both solutions to boiling and mix. Allow to cool slowly for 2 to 4 hours or preferably overnight at 15° C. Test the filtrate for lead ions with alcoholic sulfuric acid solution. Wash the precipitate with 95% ethyl alcohol until the filtrate diluted with water does not become cloudy. Transfer and wash the precipitate into a beaker with about 100 c.c. of ethyl alcohol. Add 5 grams of acetic acid and heat to boiling. The precipitate slowly dissolves. Allow to cool as before. Transfer the precipitate using ether to a beaker. Add sufficient nitric acid to dissolve the lead salts. Pour and wash the mixture into a separatory funnel and shake well. Wash with water until all nitric acid has been removed, as shown by testing the solution with methyl red. Transfer the ethereal solution to a weighed container, distill off the ether, and weigh the residue.

This procedure was followed on a 10 gram sample of the acids. Approximately 2.5 grams of lead acetate were used for complete precipitation. A yield of 2.2450 grams of the saturated acids was obtained. This is 22.45% based on the weight of the sample taken, which is identical with the value of Subba Jois and Manjunath. (11)

To check the completeness of the separation, the iodine number of the separated fatty acids was determined and a value of 3.0 obtained. This value, when compared to the iodine number of the original oil, indicates that a satisfactory separation had been made.

DRYING PROPERTIES OF THE OIL

A simple experiment was run on a sample of the oil in an attempt to get some idea of its drying properties. Thin films of oil were spread on glass plates. One set of plates was heated in an electric oven with good ventilation for 12 hours at 75° C. A definite elastic film had been formed

at the end of this time. Another set of plates was kept at room temperature for three days. A sticky film had begun to be formed at the end of this time. A further study of the drying properties of the oil will form the subject for a later investigation.

NATURE OF THE UNSAPONIFIABLE MATTER

Since various claims have been made regarding the medicinal value of the oil (3, 10, 11, 12), it was decided to make a study of the unsaponifiable matter in the hope of isolating some substance of known medicinal value, such as an alkaloid.

The yellow crystalline solid obtained in the determination of the unsaponifiable matter was repeatedly recrystallized from hot 95% ethyl alcohol and finally dried in a vacuum desiccator at room temperature. The results may be summarized below:

Recrystallizations	Color crystals	Color sol.	M.Pt. Crystals
1	light yellow	orange	131-134°C.
2	straw color	yellow	131-134°C.
3	sl. tinged	clear	131-134°C.
4	white	clear	131-134°C.

Thus, it would seem that there are at least two components present in the unsaponifiable matter, an orange to yellow solid which is alcohol-soluble and which imparts the color to the original unsaponifiable matter and a white crystalline solid which is soluble in hot alcohol but not in cold.

Several different tests were run on the white crystalline material to determine the presence or absence of alkaloidal

material. These tests were all taken from the English translation of Autenrieth's text, (2) Each of the tests was checked with known alkaloidal material, and in each case a precipitate was obtained.

An aqueous solution or suspension of the substance was treated with a 5% solution of mercuric chloride. No precipitate or cloudiness was observed, even on standing several hours.

An aqueous solution of KI-I_2 failed to give a precipitate or cloudiness with a solution of the unknown.

A 5% tannic acid solution was added to a suspension of the unknown. No precipitate or cloudiness was observed.

The unknown was treated with a saturated solution of picric acid. Again, no precipitate or cloudiness was observed.

No optical rotation was observed in a saturated alcoholic solution of the unknown.

Melzer's test (12), which consists of adding a drop of concentrated sulfuric acid to a mixture of ethyl alcohol, benzaldehyde, and the unknown, gave a red coloration, which is indicative of a sterol of some nature. Comparing these results with similar investigations of Lewkowitsch (6) and Anderson (1), it was decided that the unsaponifiable matter was most probably a mixture of phytosterol, cholesterol, and an unknown coloring matter. However, a further study should be made before any definite conclusion is reached. The above tests certainly indicate that no alkaloidal material is present.

SUMMARY

A summary of the data obtained in this investigation is listed below:

OIL

Yield, based on the weight of the seed	3.0%
Index of Refraction (25 C.)	1.4763
Specific Gravity (25 C.)	0.9256
Saponification Number	184.2
Iodine Number	116.1
Acid Value	3.25
Reichert-Meisll Number	0.44
Unsaponifiable Matter	5.2%
Saturated Fatty Acids	22.4%

SEED AND MEAL

Weight of Seed	16.3 mg.
Ash, based on weight of seed	3.28%
Calcium	0.193%
Iron	0.0304%
Magnesium	0.287%
Phosphorus	0.447%
Nitrogen (on whole seed)	3.19%
Water-soluble Ash	44.4%
Water-insoluble Ash	55.6%
Ratio of alkalinity of the water-soluble ash to water-insoluble ash	1:3.5

In any analysis of data for an investigation of this nature, not much can be said except that which is evident from the data itself. The constants of the oil definitely place it in the semi-drying class. In general, the constants obtained above check with those of previous investigators, except the one case of the acid value. A likely explanation of this variance was given above.

The seed have been shown to be rich in certain mineral

matter such as phosphorus, nitrogen, and magnesium. This suggests a possible use for the ground meal as an animal food or as a fertilizer. Alkaloids have been shown to be absent in the oil. The constituent or constituents responsible for reported medicinal properties have not been recognized. Certain enzymes causing fermentation in aqueous solutions have been found to be present in the seed.

CONCLUSION

In conclusion it may be said that an oil can be efficiently extracted from the seed of the Cassia occidentales, the physical and chemical constants of the oil have been determined or checked, a mineral analysis of the extracted meal has been made, a conclusion regarding the probable nature of the unsaponifiable portion of the oil has been made, and the oil has been partially classified.

It is planned to continue the work and to determine various other physical and chemical properties of the oil, such as, a chemical analysis of the fatty acids present, a more thorough study of the drying properties of the oil, and a study of the physiological action of the oil and seed extracts.

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